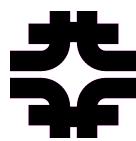


DØ Status and Tevatron Physics Results

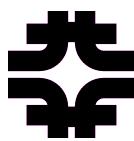
Wade Fisher / PPD-DØ
for the DØ and CDF collaborations

FRA Physics Visiting Committee
April 25/26 2008

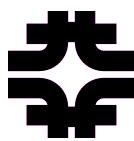


Outline

- Status of the DØ experiment
 - Data taking
 - Computing & Analysis
 - Personpower & Publication rate
 - Physics highlights from DØ & CDF
 - Quantum chromodynamics
 - Electroweak measurements
 - CP Violation studies in B meson systems
 - Standard model Higgs boson search
 - Survey of searches for New Phenomena
 - Conclusions
-



- 529 scientific authors, 83 institutions in 18 countries
- FNAL: 56 authors (33 FTE) + support from PPD/CD divisions



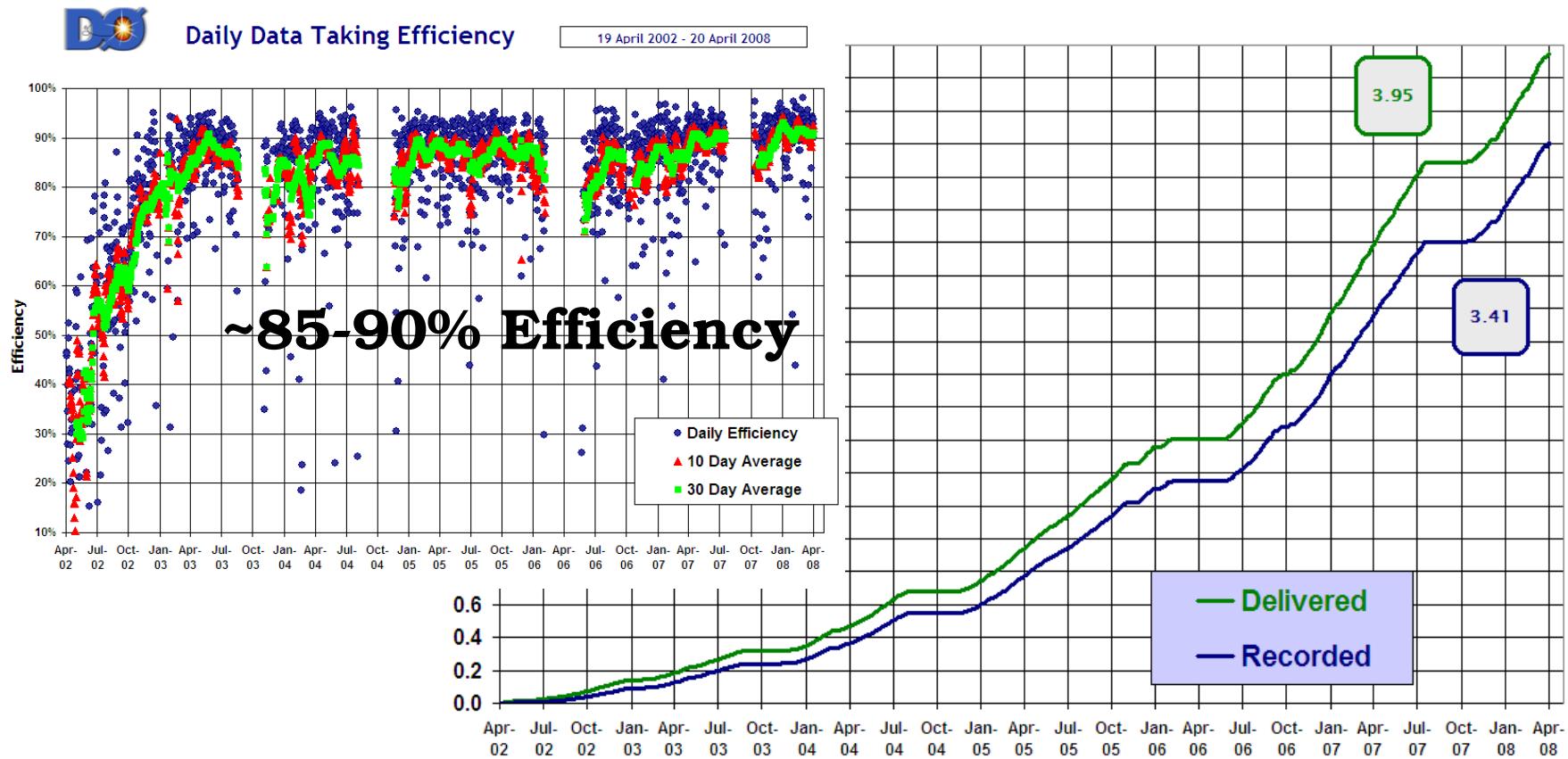
Operations and Performance

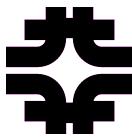
- DØ collected 3.41 fb^{-1} out of the total delivered luminosity of 3.95 fb^{-1}
 - Boosted by Accelerator Division's recent records in proton-stacking, peak luminosity and luminosity/week



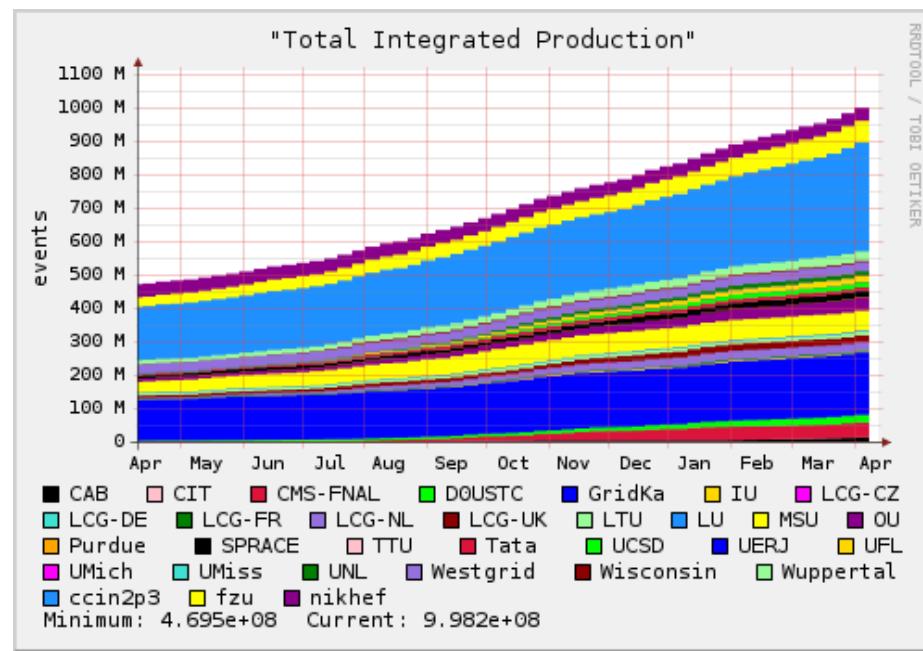
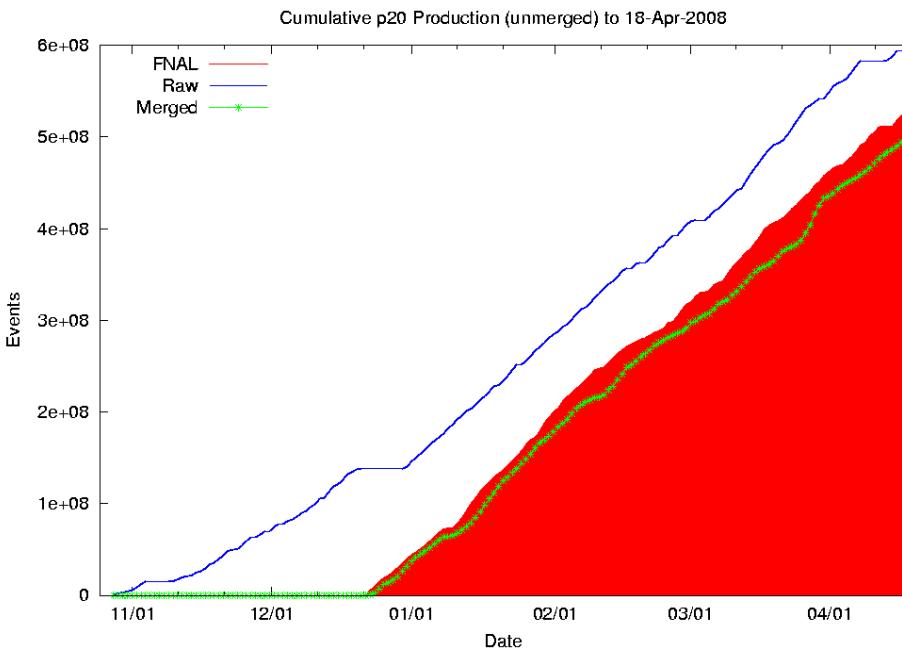
Run II Integrated Luminosity

19 April 2002 - 20 April 2008

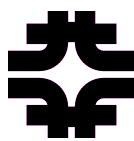




Data Processing and MC Production



- Raw data reconstruction uses DØ controlled resources, accessed via grid interface
 - Allows seamless access to larger CPU pool if needed
- Many analyses enjoy data collection to analysis times of ~1 week
- Monte Carlo uses detailed GEANT simulation with zero-bias data overlaid
 - Typically produce 10-15 million events per week
- Grid-based processing further maximizes CPU power

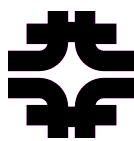


DØ Personpower Analysis

- Estimates of available full-time-equivalent physicists (FTE's) are obtained from an analysis of the Memoranda of Understanding (MoU's) submitted by each institution on DØ
 - Used to assess needs for data collection, processing, and analysis
 - Designed to overlap one year in each set to monitor changes in expectations

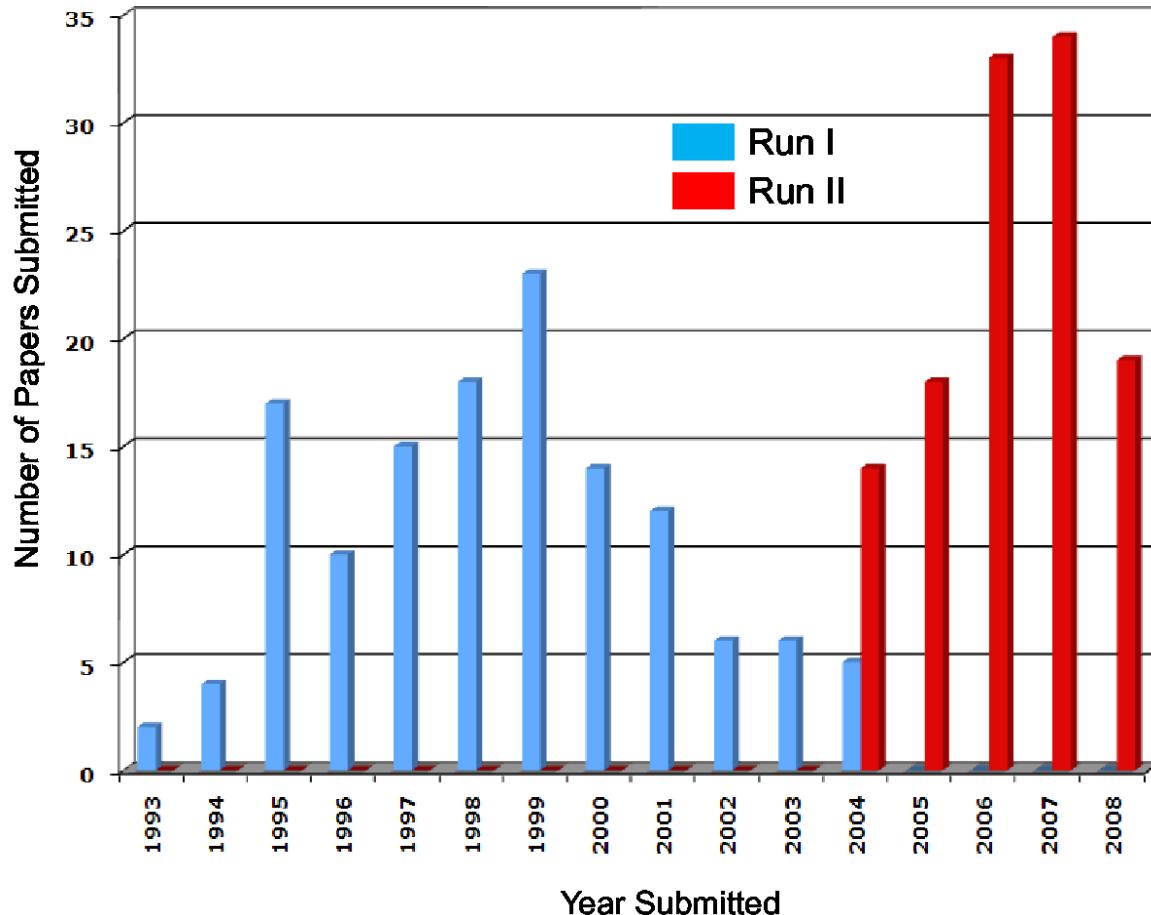
Physicist FTE's	2005	2006	2007	2008	2009	2010	2011
2005-2007 MoU data	474	437	354				
2007-2009 MoU data			357	272	184		
2009-2011 MoU data					240	185	119
Needs (excl. analysis)	230	200	165	145	124	~100	

- 30% increase in 2009 FTE projection demonstrates strengthened commitment of the collaboration to continuing the Tevatron program
- Current FTE estimates for 2010 match previous estimates for 2009
 - Expect sufficient but lean person power for 2010 run

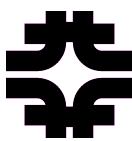


DØ Physics Analysis

History of DØ Paper Submissions to Peer-Reviewed Journals

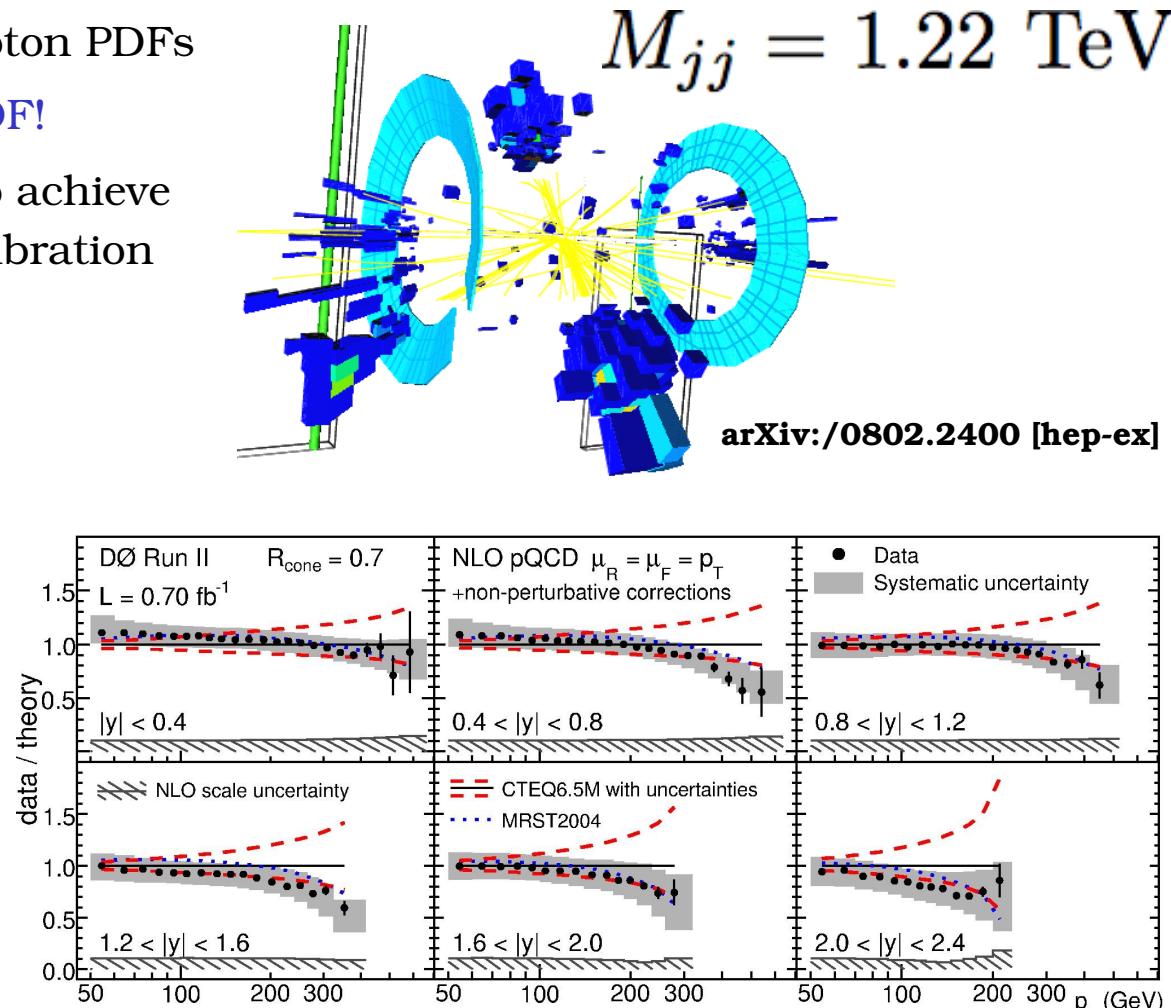
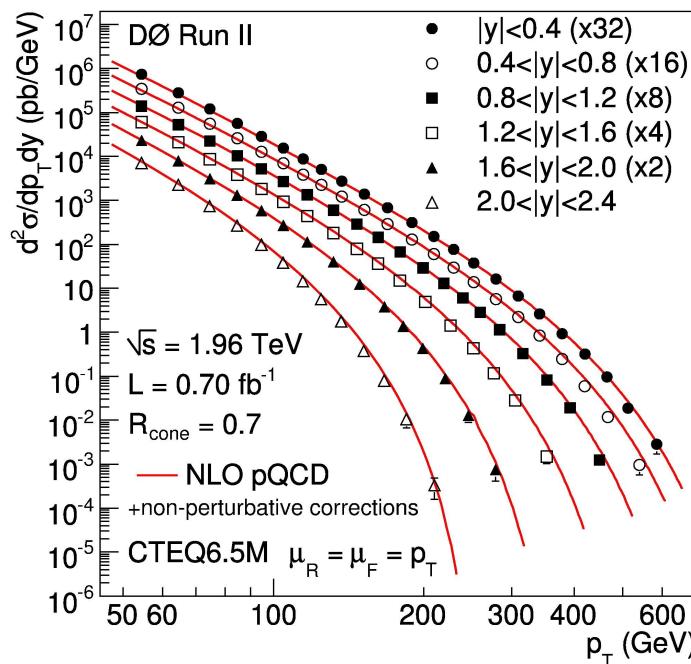


- 96 DØ publications so far in Run II
 - Planning to celebrate 100 Run II publications by May collab. meeting
- DØ submissions in 2008 are on track to surpass 2007 value
 - To date, 19 submissions in just 15 weeks

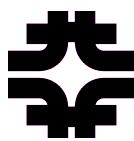


Inclusive Jet Production

- Direct input to proton/anti-proton PDFs
 - Already in MSRTW2008 PDF!
- Relies upon multi-year effort to achieve ~1% precision in jet energy calibration
 - Systematics play large role



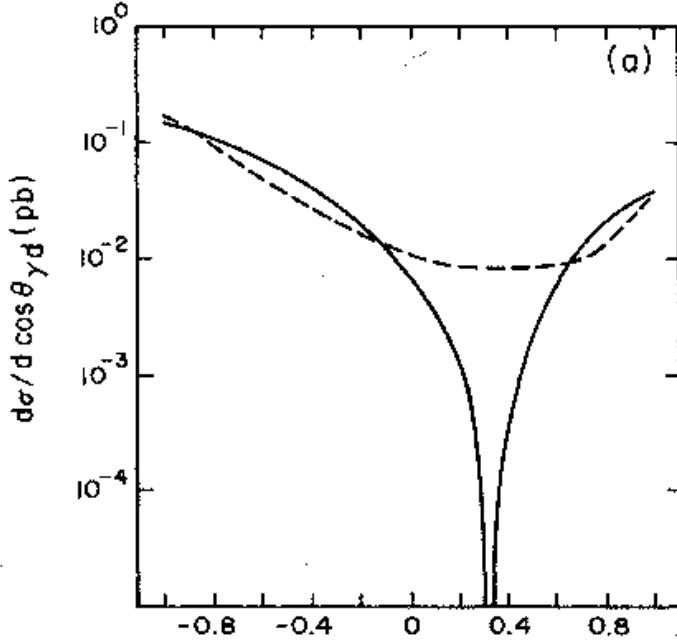
Most precise measurement and over widest kinematic range to date



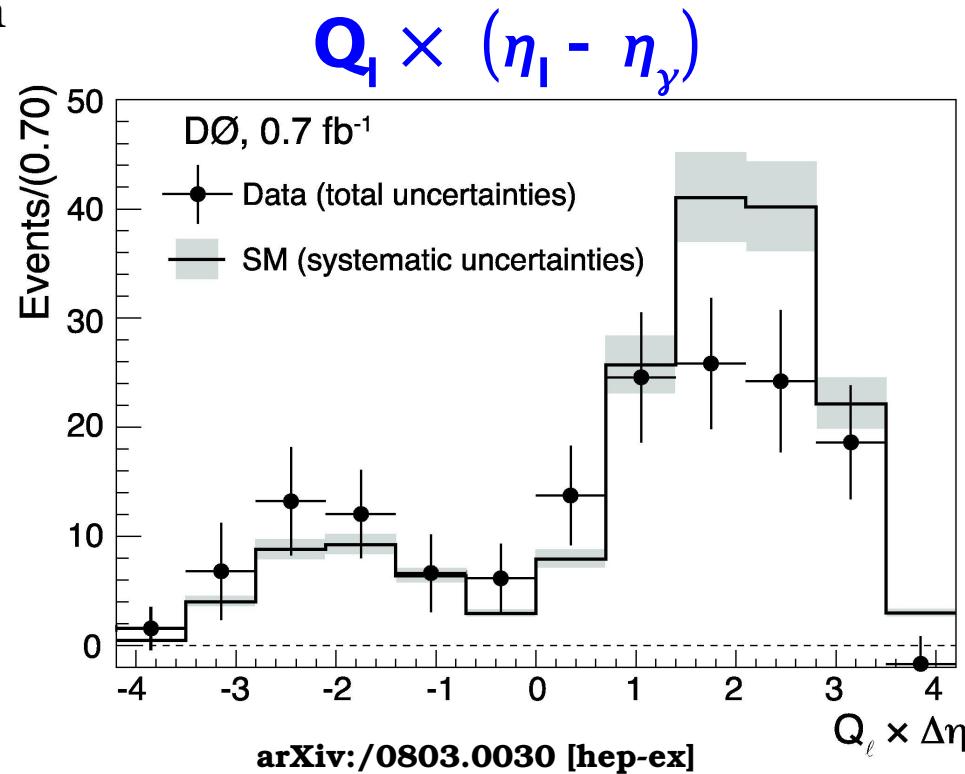
Radiation Amplitude Zero

- Destructive interference between production diagrams leads to “Zero” in angular distribution

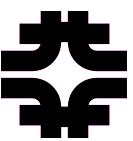
$$d\bar{u} \rightarrow W^- \gamma$$



$$\cos(\theta_{\gamma d}) = \frac{\cos \theta_{\gamma d}}{q_d + q_u} = -\frac{1}{3}$$



First indication of Radiation Amplitude Zero!



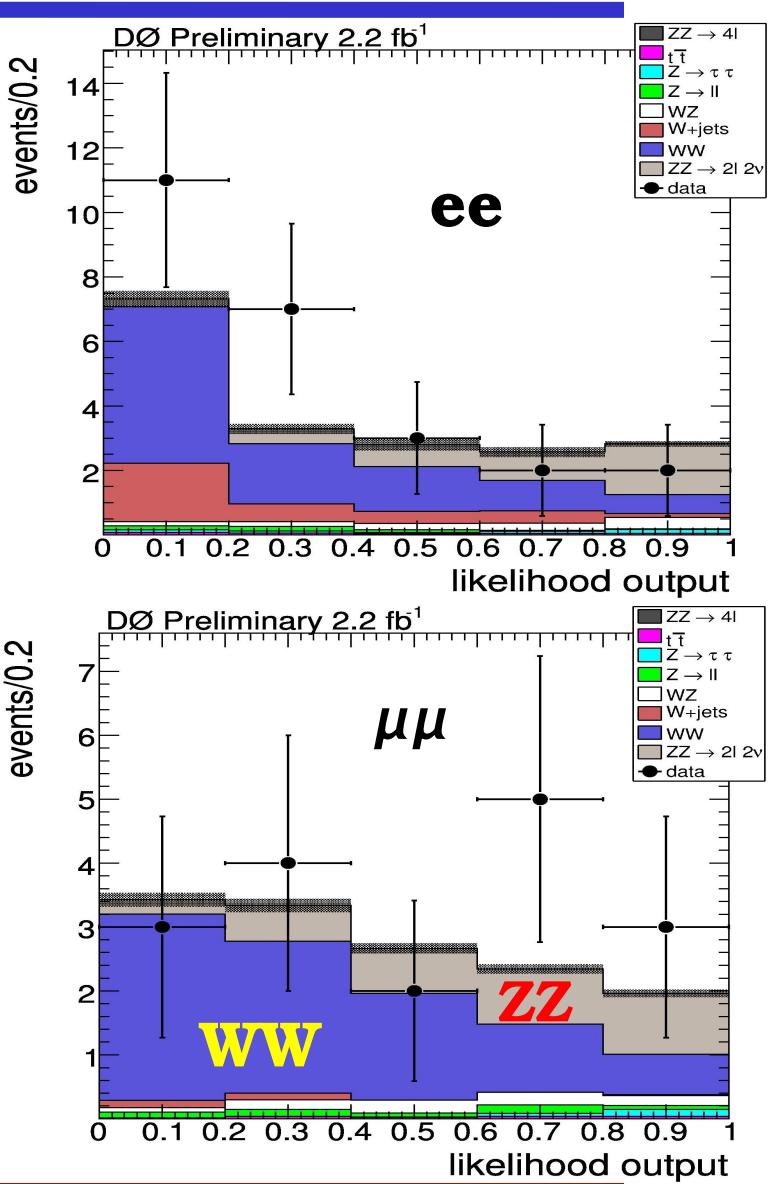
ZZ \rightarrow ll $\nu\nu$

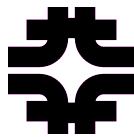
- $\sigma(\text{SM}) = 1.6 \pm 0.1 \text{ pb}$, $\text{BR}(\text{ZZ} \rightarrow \text{ll}\nu\nu) = 2.6\%$
- Events classified via likelihood discriminant:
 - Di-lepton mass
 - PT of the leading lepton
 - Scattering angle of negative lepton in di-lepton rest frame
 - Angle between the leading lepton and di-lepton system

$$\sigma(ZZ) = 2.1 \pm 1.1 (\text{stat}) \pm 0.4 (\text{syst}) \text{ pb}$$

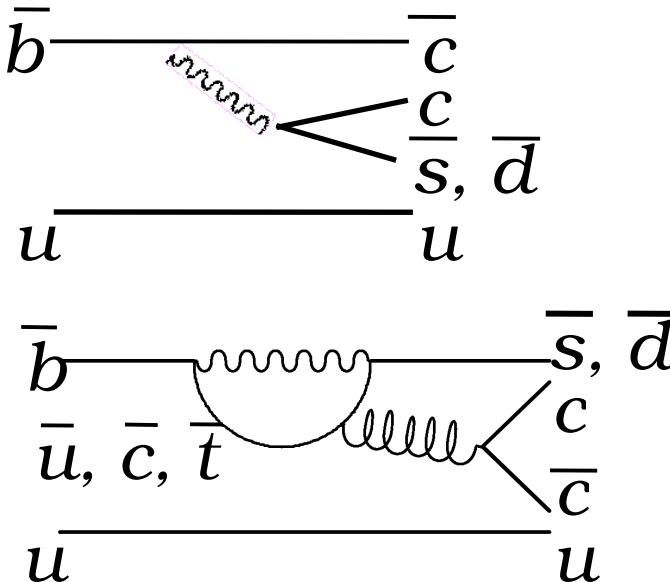
Observed significance: 2.4σ

Expected significance: 1.8σ





Direct CP Violation in $B^\pm \rightarrow J/\Psi K^\pm(\pi^\pm)$



- CPV in SM due to different complex phases
 - New physics may alter this phase
 - Measure asymmetry in K^+/π^+ vs K^-/π^-
- Frequent reversals of DØ magnet polarity critical to achieve this precision
 - Improves $A(B^\pm \rightarrow J/\Psi K^\pm)$ WA precision by $2\times$
 - Statistics-limited, but already in the “interesting” range

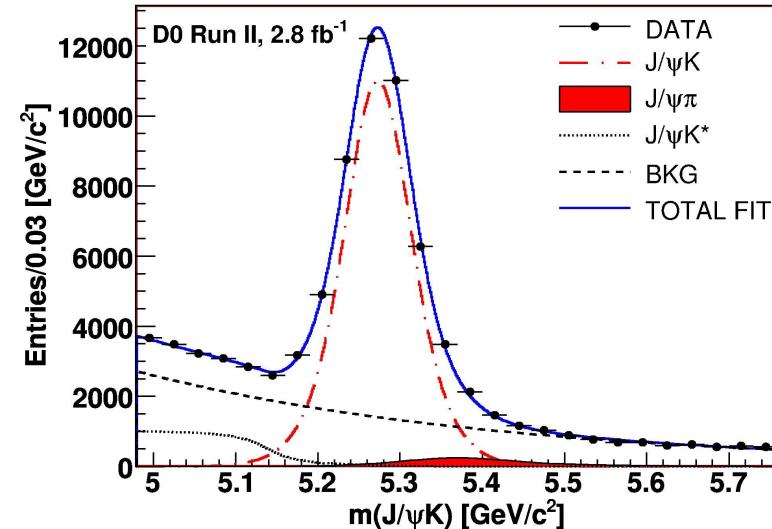
arXiv:/0802.3299 [hep-ex]

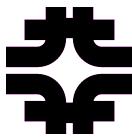
$A(B^\pm \rightarrow J/\Psi K^\pm) \approx 0.003$ (SM)

$0.0074 \pm 0.0061(stat) \pm 0.0027(syst)$

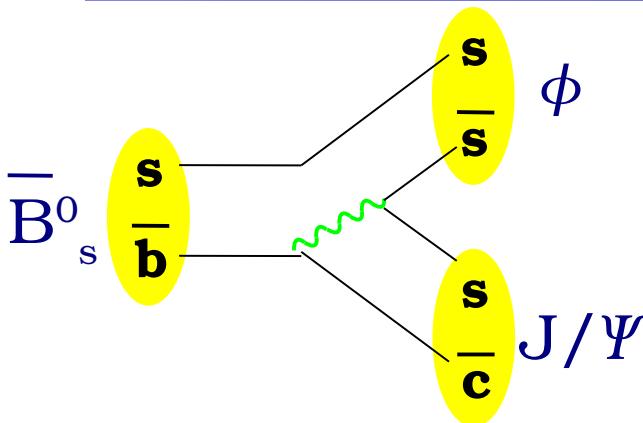
$A(B^\pm \rightarrow J/\Psi \pi^\pm) \approx 0.01$ (SM)

$-0.09 \pm 0.08(stat) \pm 0.03(syst)$



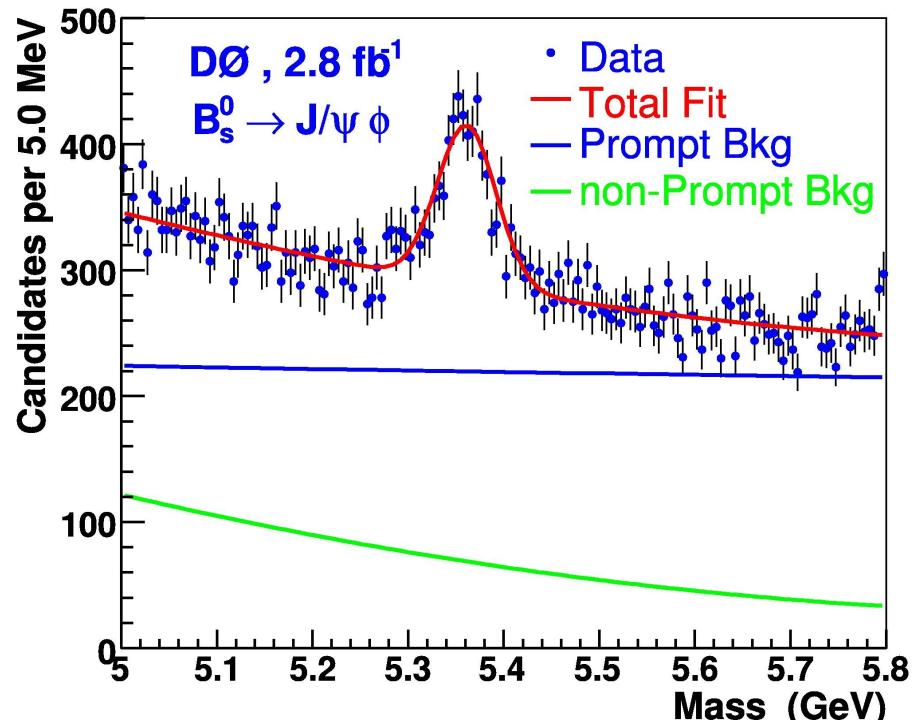


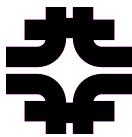
CP Violation in $B_s^0 \rightarrow J/\Psi \phi$



- Assuming no CPV, heavy (CP-even) & light (CP-odd) B_s^0 states decay into vector mesons
 - Time dependent angular distributions allow separation of components
 - Simultaneous fit to lifetime, mass and three angles
 - New part of the CKM matrix compared to B factories

- CP violating phase in B_s^0 system expected to be small: $\varphi_s = -2\beta_s = -0.038$
 - Very sensitive to new physics altering the phase: $\varphi_s = -2\beta_s + \varphi^{NP}$





CP Violation in $B_s \rightarrow J/\Psi \phi$

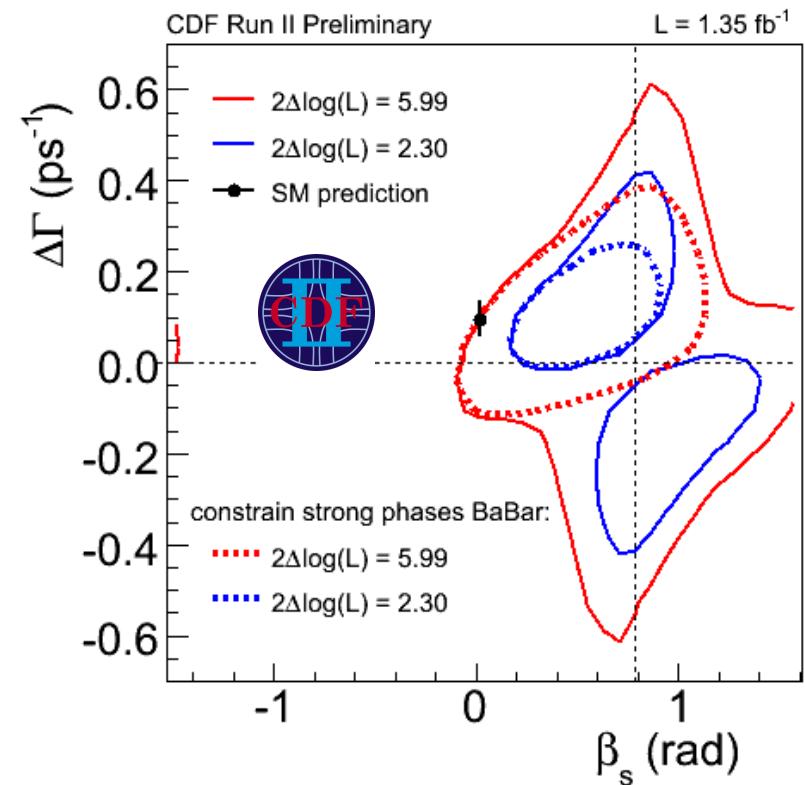
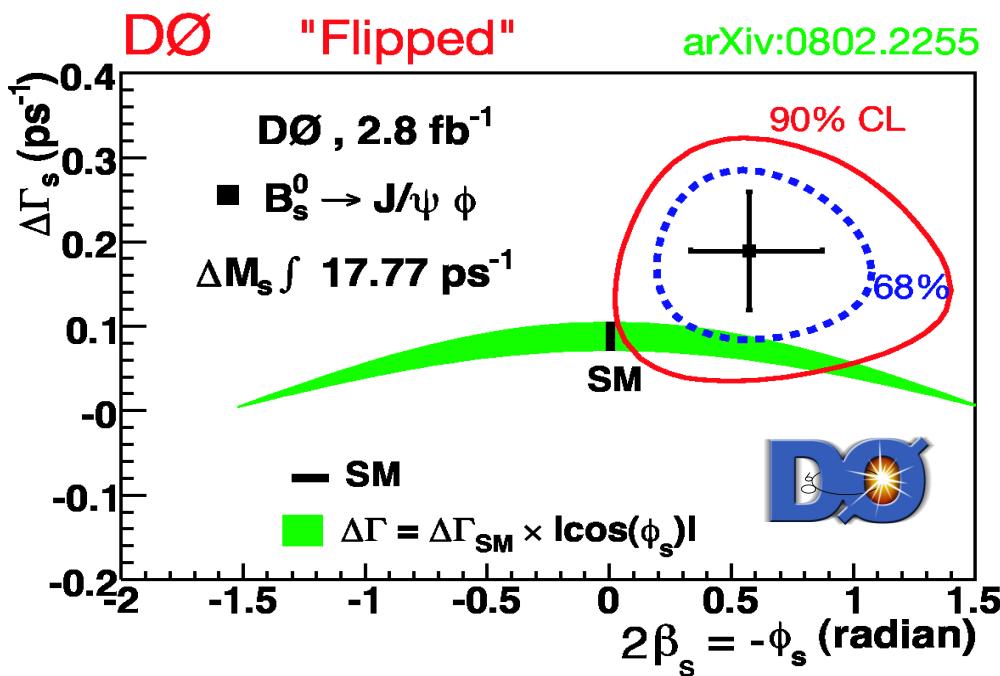
DØ Results:

$$\varphi_s = -0.57^{+0.24}_{-0.30} (stat)^{+0.07}_{-0.02} (syst)$$

$$\varphi_s (SM) = -0.038 \pm 0.002$$

SM p-Value: 6.6%

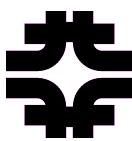
[arXiv:/0802.2255 \[hep-ex\]](https://arxiv.org/abs/0802.2255)



CDF Results: [arXiv:/0712.2348 \[hep-ex\]](https://arxiv.org/abs/0712.2348)

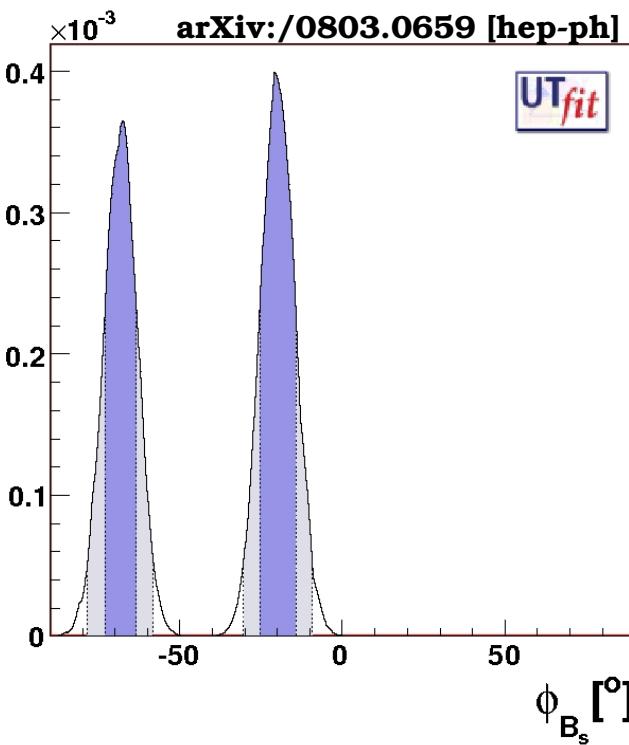
At 68% CL:

$$2\beta_s \in [0.24, 1.36] \cup [1.78, 2.90]$$



A Crack in the SM?

Probability density



FIRST EVIDENCE OF NEW PHYSICS IN $b \leftrightarrow s$ TRANSITIONS (UTfit Collaboration)

M. Bona,¹ M. Ciuchini,² E. Franco,³ V. Lubicz,^{2,4} G. Martinelli,^{3,5} F. Parodi,⁶ M. Pierini,¹ P. Roudeau,⁷ C. Schiavi,⁶ L. Silvestrini,³ V. Sordini,⁷ A. Stocchi,⁷ and V. Vagnoni⁸

¹CERN, CH-1211 Geneva 23, Switzerland

²INFN, Sezione di Roma Tre, I-00146 Roma, Italy

³INFN, Sezione di Roma, I-00185 Roma, Italy

⁴Dipartimento di Fisica, Università di Roma Tre, I-00146 Roma, Italy

⁵Dipartimento di Fisica, Università di Roma "La Sapienza", I-00185 Roma, Italy

⁶Dipartimento di Fisica, Università di Genova and INFN, I-16146 Genova, Italy

⁷Laboratoire de l'Accélérateur Linéaire, IN2P3-CNRS et Université de Paris-Sud, BP 34, F-91898 Orsay Cedex, France

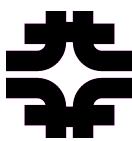
⁸INFN, Sezione di Bologna, I-40126 Bologna, Italy

We combine all the available experimental information on B_s mixing, including the very recent tagged analyses of $B_s \rightarrow J/\Psi\phi$ by the CDF and DØ collaborations. We find that the phase of the B_s mixing amplitude deviates more than 3σ from the Standard Model prediction. While no single measurement has a 3σ significance yet, all the constraints show a remarkable agreement with the combined result. This is a first evidence of physics beyond the Standard Model. This result disfavours New Physics models with Minimal Flavour Violation with the same significance.

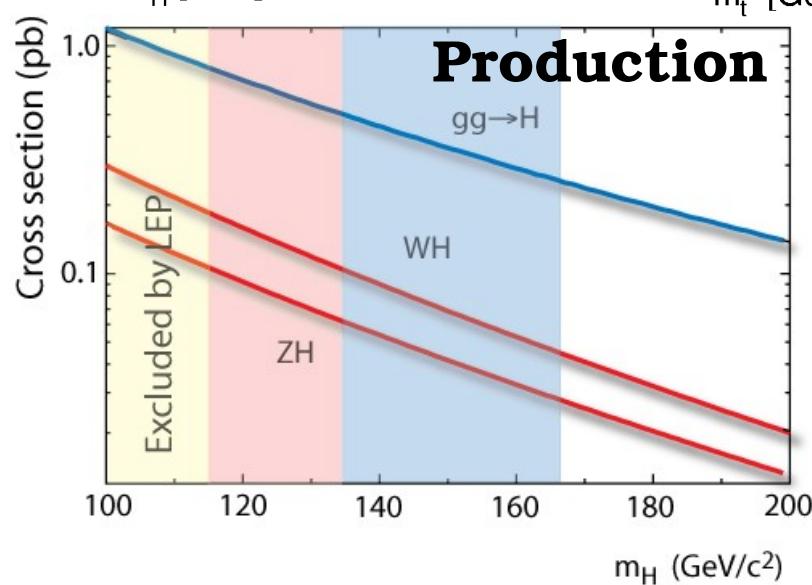
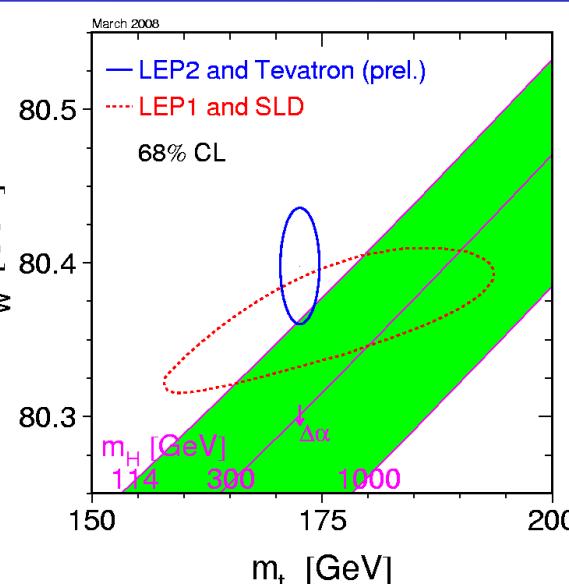
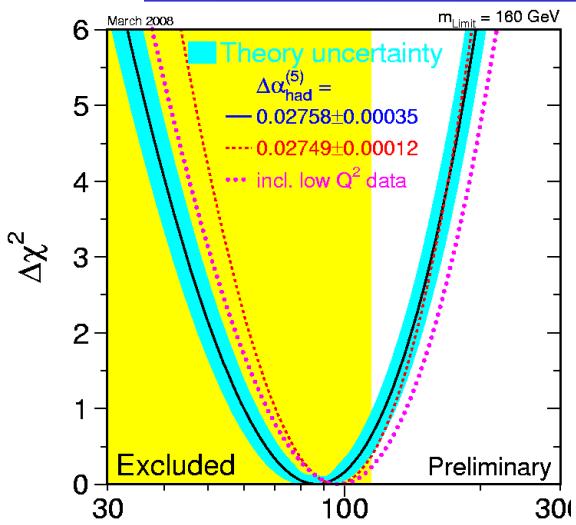
deviates more than 3σ from the Standard Model prediction.

4 of 6 inputs unique to Tevatron, 6 of 6 include Tevatron results.

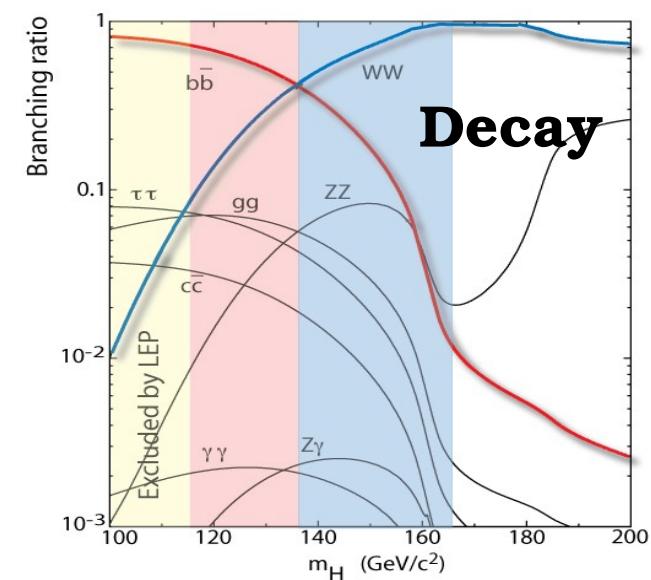
DØ and CDF continue very active studies of the heavy flavor sector.
Tevatron results statistically limited and we are eagerly awaiting updated results with increased precision.

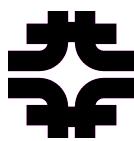


Standard Model Higgs Search

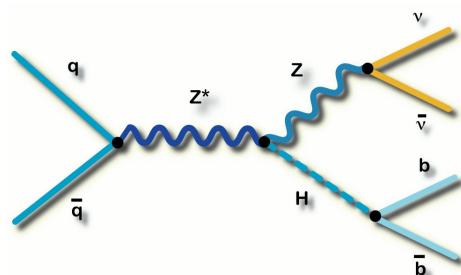


- Indirect EW evidence points to a low mass Higgs: $m_H < 200 \text{ GeV}/c^2$
 - Matches Tevatron kinematics well
 - Search focuses on Higgs decays to b quark and W boson pairs



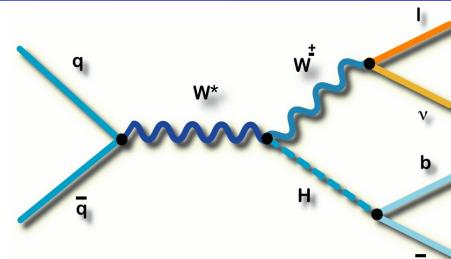


Associated Higgs Production



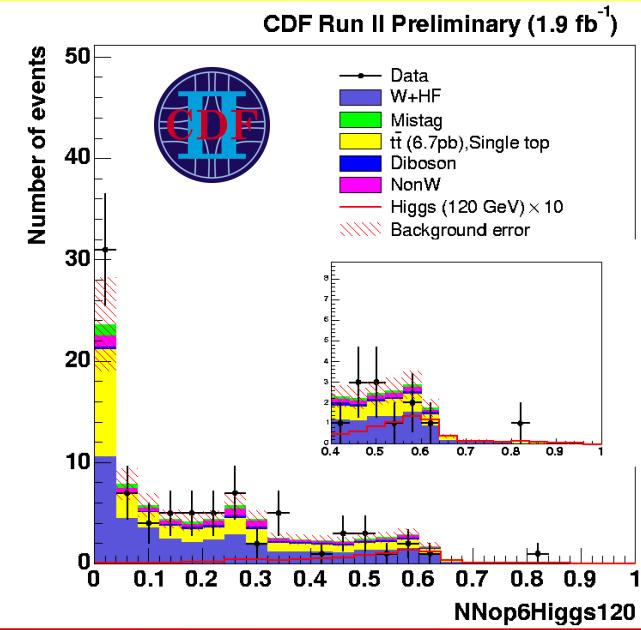
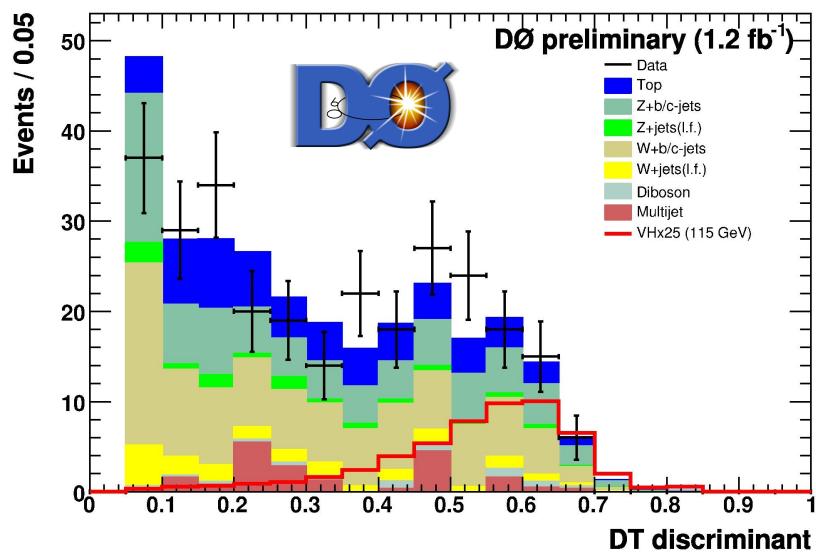
ZH $\rightarrow\nu\nu bb$:

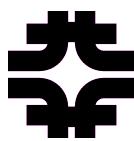
2 high- p_T , b-tagged acoplanar jets
Large missing E_T



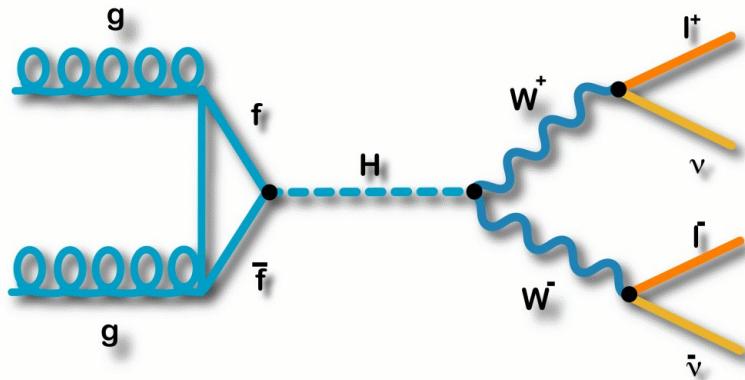
WH $\rightarrow l\nu bb$:

high- p_T lepton + missing E_T
2 high- p_T , b-Tagged jets



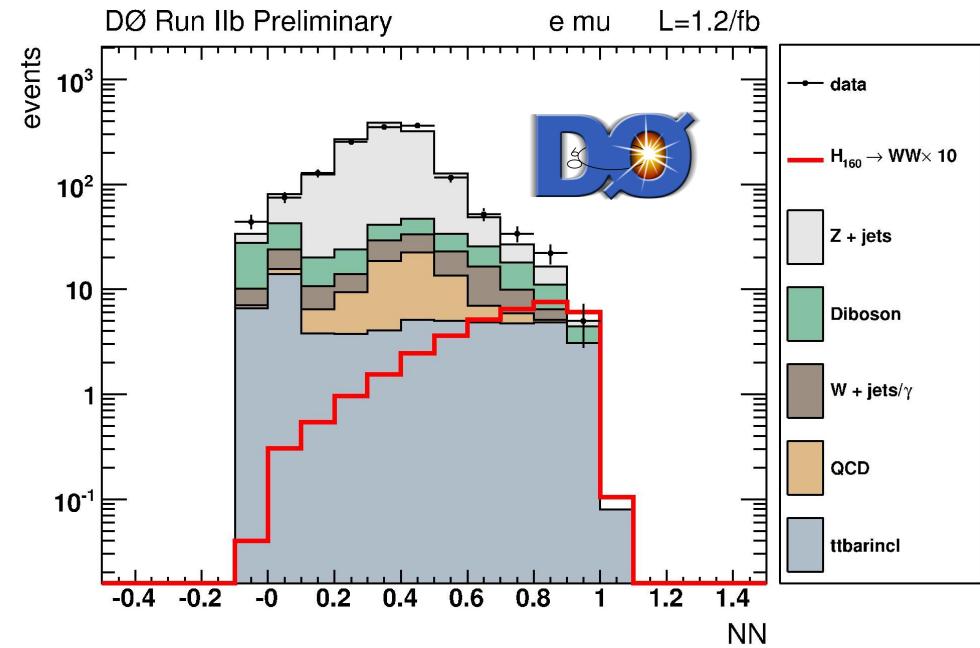
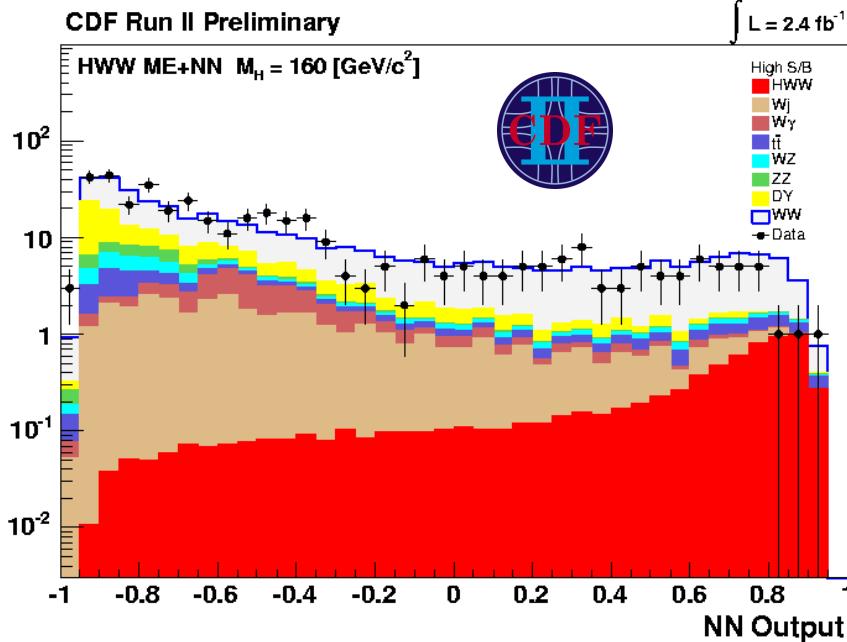


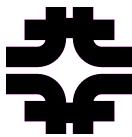
Gluon Fusion Higgs Production



H \rightarrow WW \rightarrow llll:

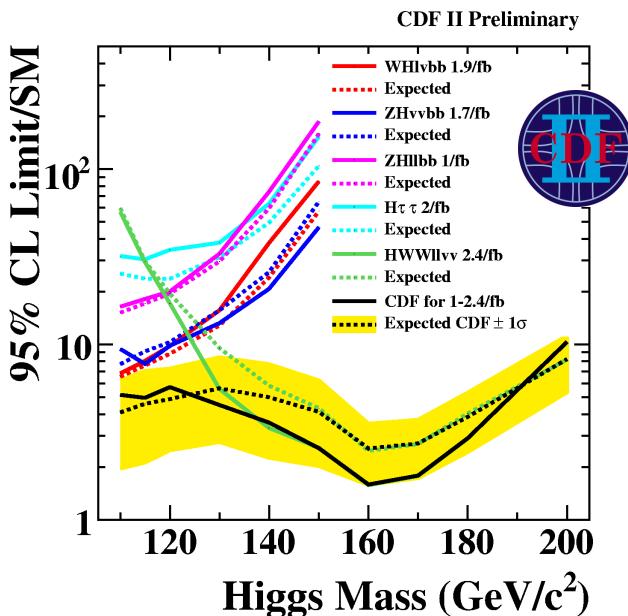
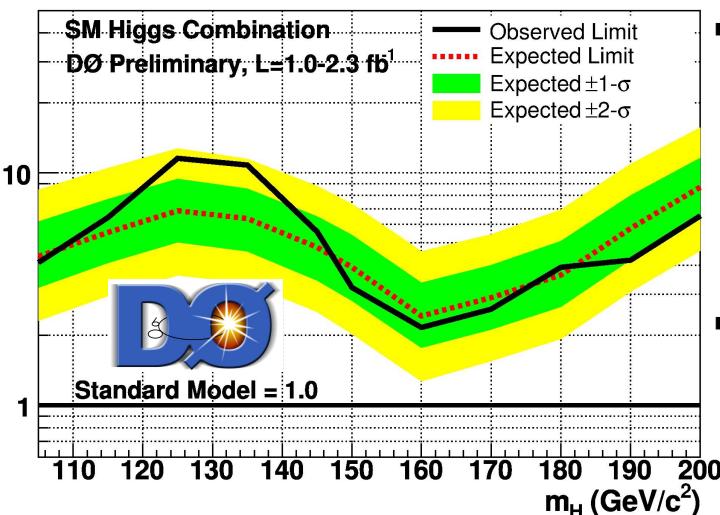
two high- p_T leptons + missing E_T
Spin-correlation between leptons
helps remove SM WW bkgd



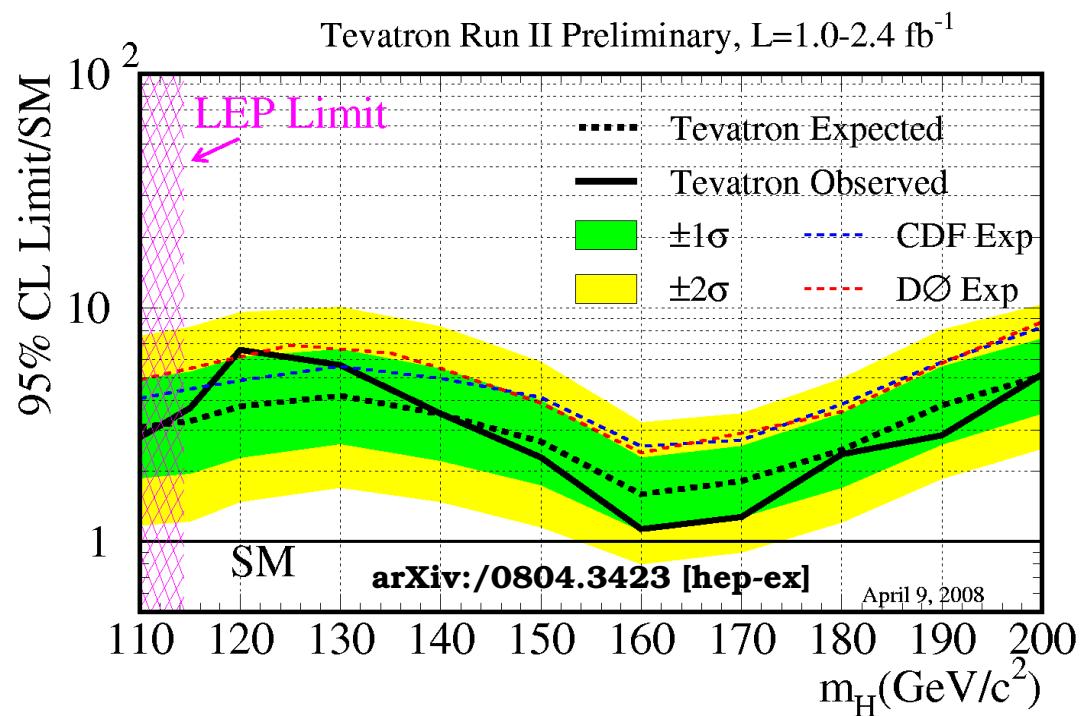


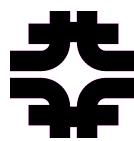
SM Higgs Cross Section Limits

Limit / σ_{SM}



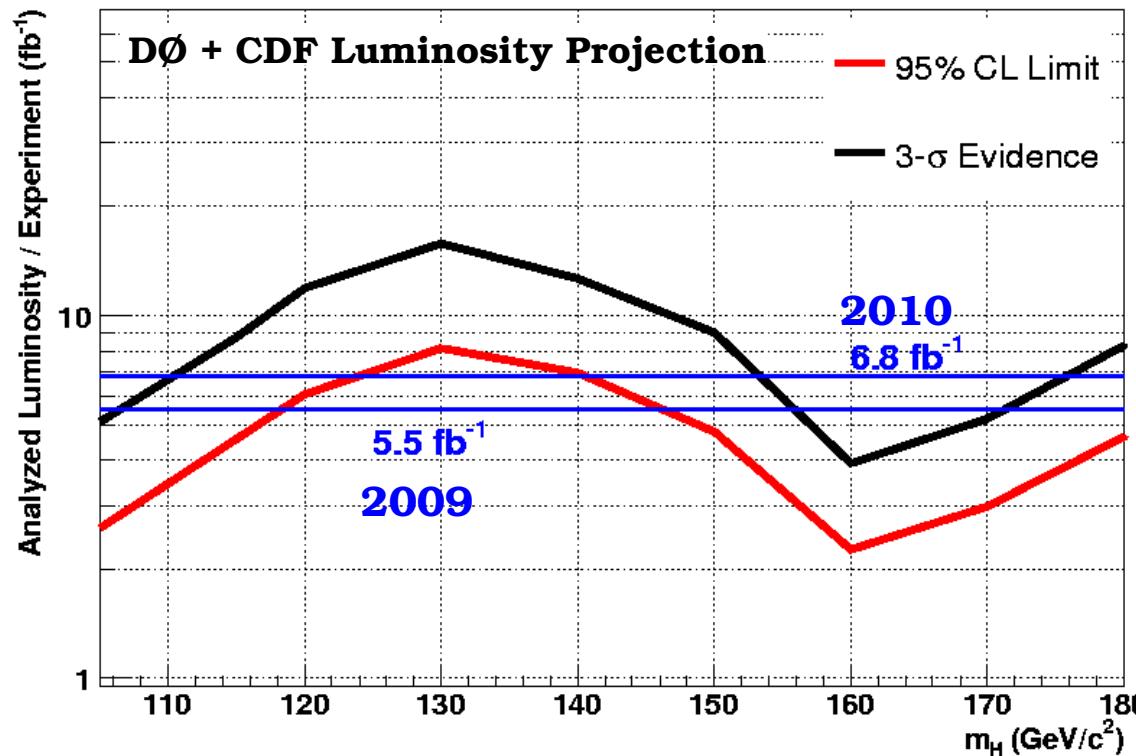
- Current limits surpassing lumi-only progress via constant analysis improvement
 - Adding new channels (esp. low mass)
 - Improved energy resolution, acceptance
- Limit/SM **obs(exp)**: **3.7 (3.3)** at $115 \text{ GeV}/c^2$
1.1 (1.6) at $160 \text{ GeV}/c^2$

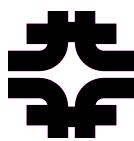




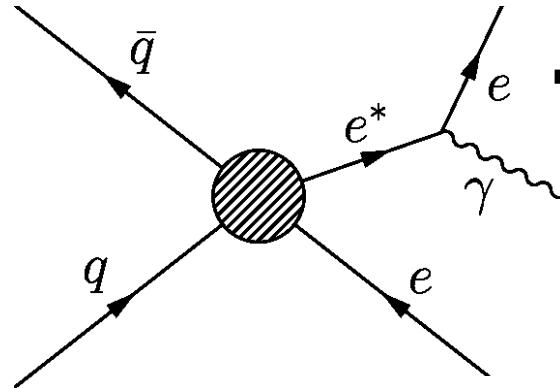
SM Higgs Projections

- By analyzing current progress and planned analysis improvements, projections for future performance can be made
 - Assumes DØ+CDF combination & analysis improvements
 - Analyzed luminosity is ~80% of delivered
 - 2009: 5.5 fb^{-1} , 2010: 6.8 fb^{-1}

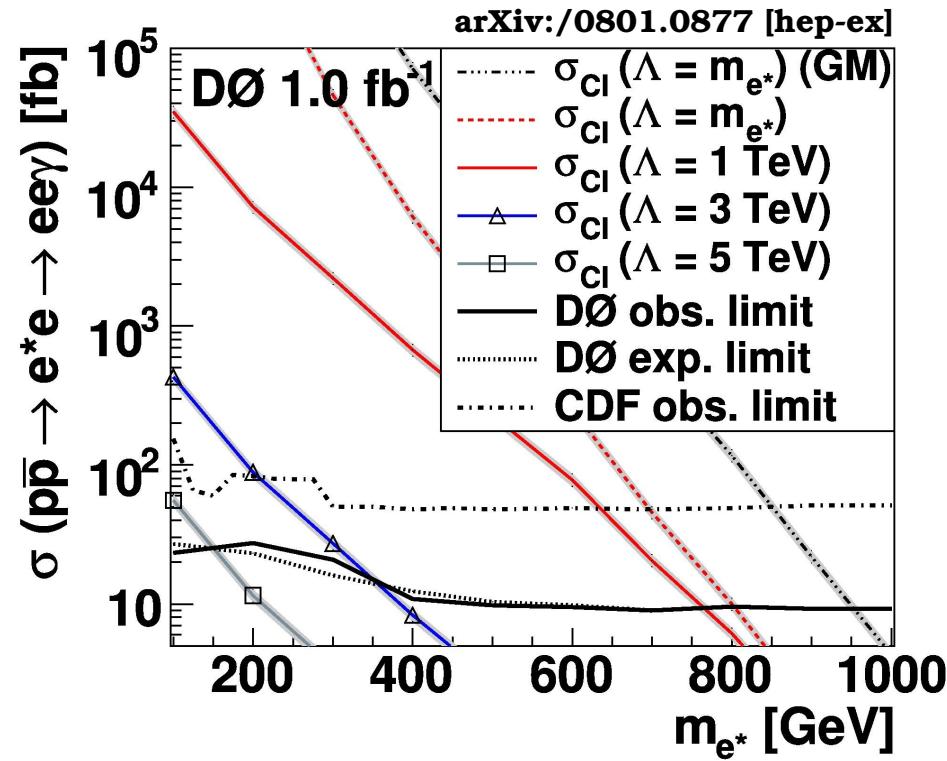
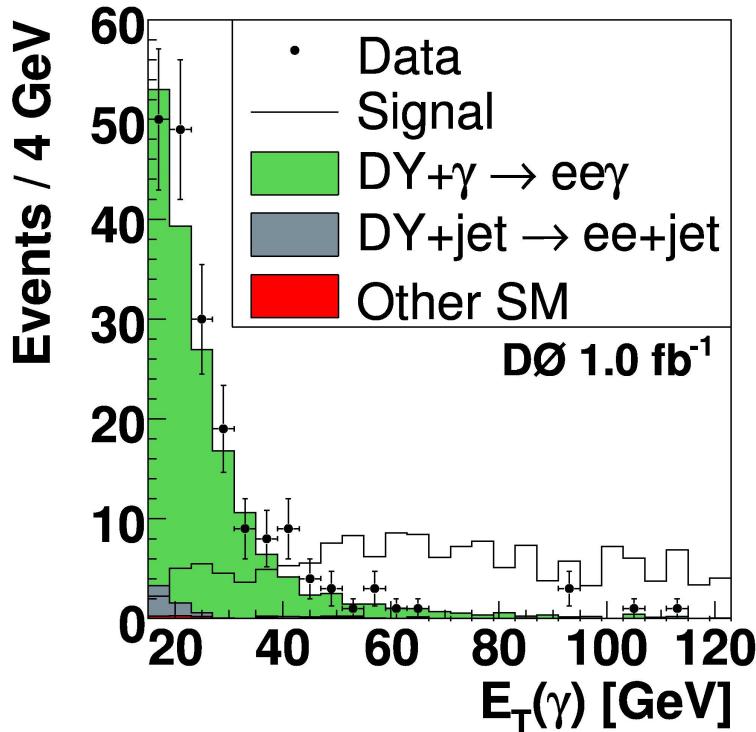


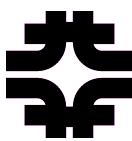


Exotics: Excited Electrons

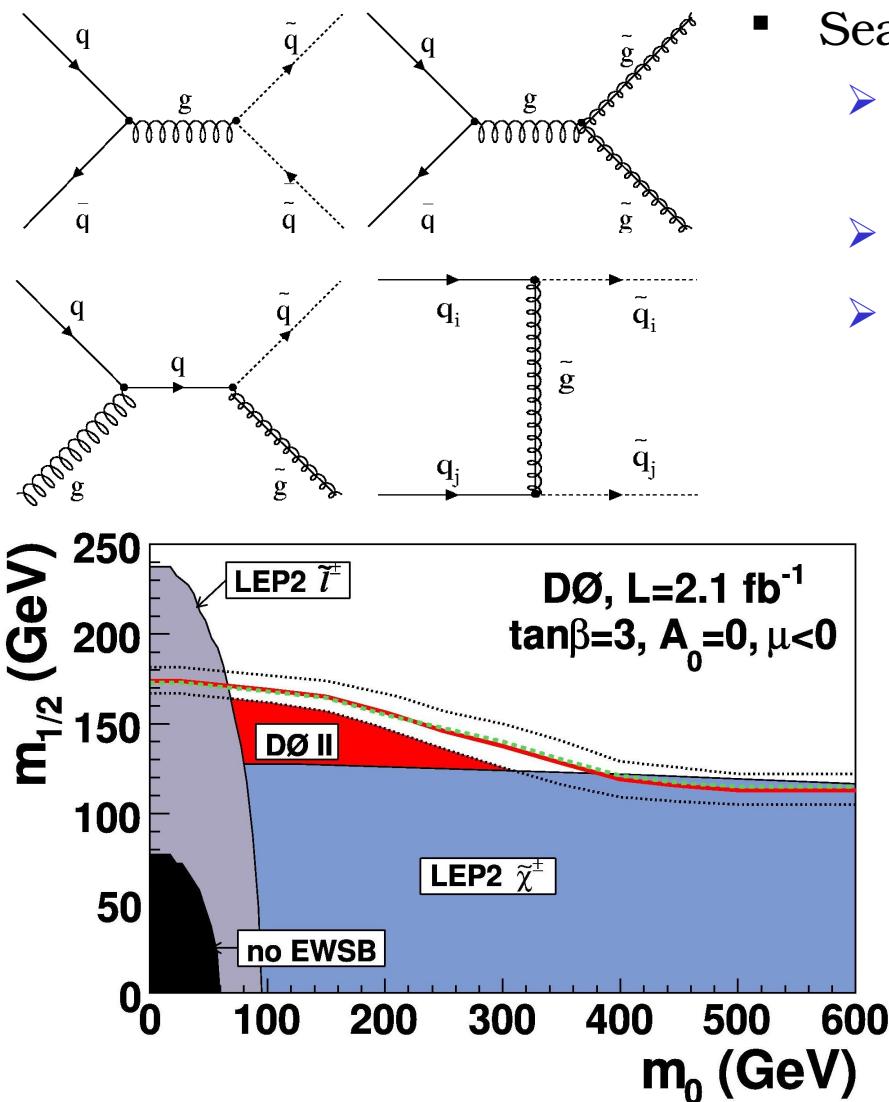


- Compositeness as a source of quark-lepton hierarchy
 - 3 fermion or fermion+boson bound states coupling to ordinary matter via contact interactions
 - Search for excited electron states in EM+photon

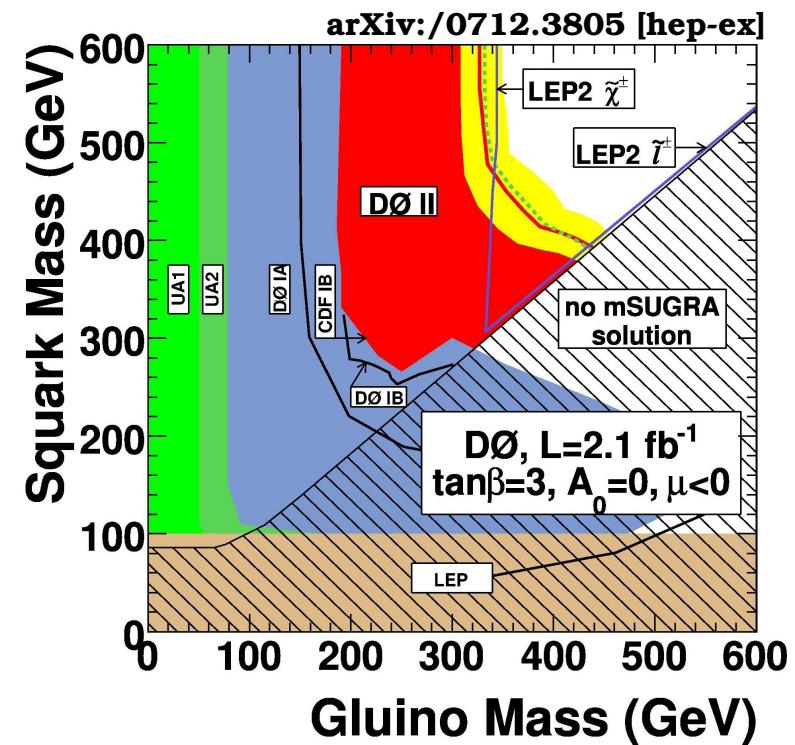


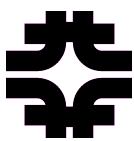


SUSY: Squarks & Gluinos

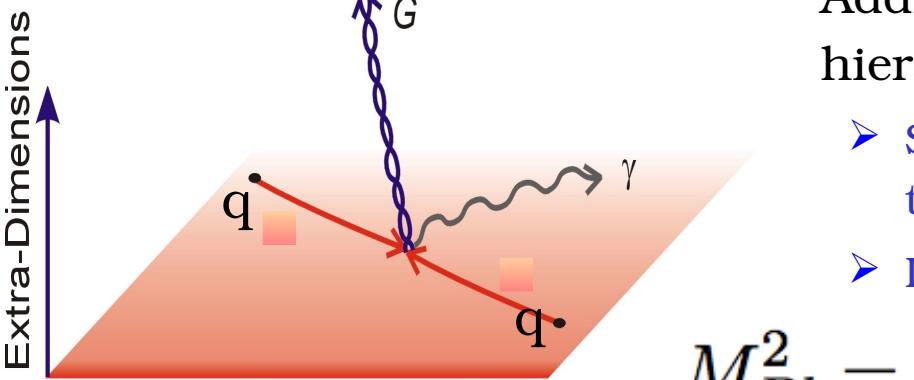


- Search for multijets with large missing ET
 - 3 analyses optimized for different topologies: 2, 3 and 4 jets
 - Most constraining limits on mSUGRA
 - **m_0 : scalar mass, $m_{1/2}$: gaugino mass**





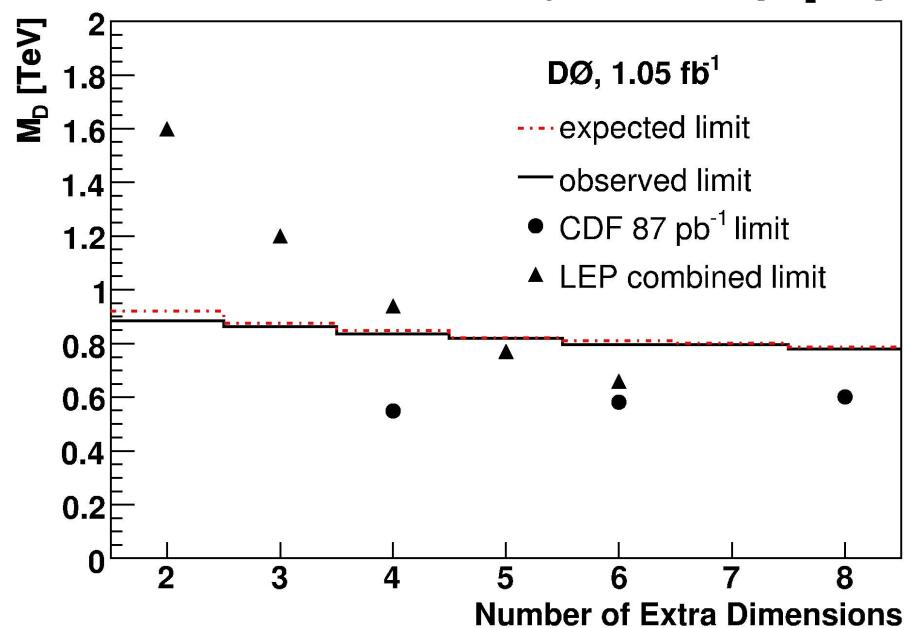
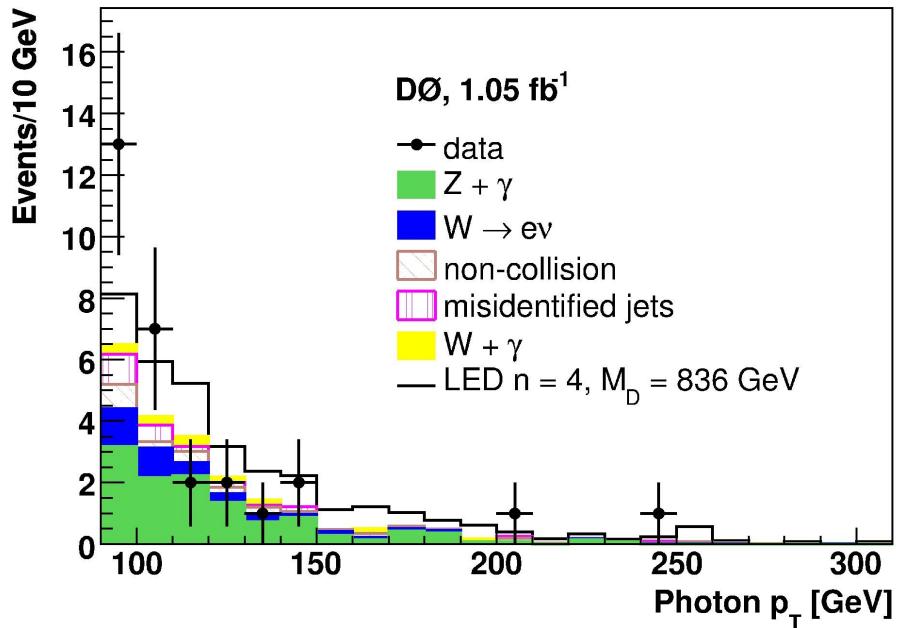
Extra Dimensions: Kaluza-Klein Gravitons

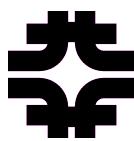


- Addressing gravity's relative weakness: hierarchy problem
 - Search for high-energy mono-photons back-to-back with large missing ET
 - Improving LEP limits at large # of LED

$$M_{Pl}^2 = 8\pi M_D^{\delta+2} R^\delta$$

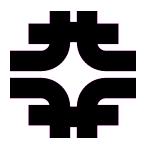
arXiv:/0803.2137 [hep-ex]





Conclusions

- DØ operating at high efficiency and demonstrating fast collection-to-analysis turnaround time
 - Wide and growing range of physics analyses being completed at a record rate & expect to continue this rate throughout the year
 - 2008: 19 submitted papers in 15 weeks
 - Many analyses statistics-limited: large and exciting potential for improvements in 2009-2010 Tevatron runs
 - Projected manpower adequate to support running through 2010
 - Excitement of Tevatron potential boosting numbers
 - DØ+CDF combination efforts underway to fully exploit the Tevatron's physics potential in precision measurements (e.g. M_{top}) and searches (e.g. Higgs)
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BACKUP SLIDES
